Comparison in the $\pm 20^\circ$ latitudinal belt
Regional differences
Effects of PARASOL drift on instantaneous albedo
POLDER RB3: diurnal extrapolation
First results with new models
Perspectives

Comparison between CERES/AQUA and POLDER/PARASOL shortwave fluxes: analysis of POLDER/PARASOL diurnal extrapolation

Simonne Guilbert, Frédéric Parol, Céline Cornet, Nicolas Ferlay, and François Thieuleux

Laboratoire d’Optique Atmosphérique
Université de Lille
Main motivations

Assess 9 years of POLDER-3 shortwave fluxes

- Viollier et al., 2002 → Shortwave fluxes from POLDER observations
- POLDER is a spectral radiometer: need to compare the results to an ERB-dedicated instrument

Prepare for upcoming mission

- POLDER heritage instrument: 3MI (Fougnie et al., 2018)
- Multi-Viewing Multi-Channel Multi-Polarization Imager
- Three instruments (2024, 2030, 2037) → 20+ years of measurements
- Could benefit from the results of this study

Fig. 1: 3MI instrument, illustration (credit ESA)
**PARASOL mission**

- Mission was to last from 2005 to 2007 → 2005 to 2013
- Flew in the Afternoon Train along *Aqua*
  → Coincident measurements with CERES/Aqua for 2005-2009
- December 2009: PARASOL moved out of the A-Train → Local time of measurement changed along with Solar Zenith Angle (SZA).

→ Impacted the computation of monthly means of SW fluxes
ERB-dedicated vs non-dedicated instruments

Clouds and the Earth’s Radiant Energy System

Comparison in the ±20° latitudinal belt

Regional differences

Effects of PARASOL drift on instantaneous albedo

POLDER RB3: diurnal extrapolation

First results with new models

Perspectives

ERB-dedicated vs non-dedicated instruments

Clouds and the Earth’s Radiant Energy System

Comparison between CERES/AQUA and POLDER/PARASOL shortwave fluxes: analysis of POLDER/PARASOL diurnal extrapolation

POLarization and Directionality of the Earth’s Reflectances System

SW Channel: 0,3-5µm

TOT Channel: 0,3-100µm

WN Channel: 8-12 µm

Spectral radiometer:

9 channels

Multidirectionality : → 16 viewing directions

Polarization state for 3 channels
Monthly means of shortwave fluxes

Comparison in the ±20° latitudinal belt
Regional differences
Effects of PARASOL drift on instantaneous albedo
POLDER RB3: diurnal extrapolation
First results with new models
Perspectives

Shortwave radiances
Angular Distribution Models (ADMS)
Shortwave fluxes & albedos
Diurnal extrapolation and monthly averaging
Monthly means of shortwave fluxes

CERES SSF1deg_month
ERBE-like extrapolation
Constant cloudiness assumption

Narrowband radiances
Plane/parallel atmospheric model
Spectral albedos
Spectral integration
Shortwave albedo
Diurnal extrapolation and monthly averaging
Monthly means of shortwave fluxes
POLDER RB3
ERBE-like + clim database
Accounts for evolution of cloudiness

Su et al., 2015
Doelling et al., 2013
Buriez et al., 2005
Buriez et al., 2007
Viollier et al., 2002
Comparison in the ±20° latitudinal belt
Regional differences
Effects of PARASOL drift on instantaneous albedo
POLDER RB3: diurnal extrapolation
First results with new models

Monthly means of shortwave fluxes

Shortwave radiances
Angular Distribution Models (ADMS)

Shortwave fluxes & albedos

Diurnal extrapolation and monthly averaging

Monthly means of shortwave fluxes

CERES SSF1deg_month
ERBE-like extrapolation
Constant cloudiness assumption

CERES SYN1deg_month
CERES + GEO extrapolation
Accounts for evolution of cloudiness

Narrowband radiances
Plane/parallel atmospheric model

Spectral albedos
Buriez et al., 2005

Spectral integration

Shortwave albedo
Buriez et al., 2007

Diurnal extrapolation and monthly averaging

Monthly means of shortwave fluxes

POLDER RB3
ERBE-like + clim database
Accounts for evolution of cloudiness

Comparison between CERES/AQUA and POLDER/PARASOL shortwave fluxes: analysis of POLDER/PARASOL diurnal extrapolation
Shortwave fluxes POLDER/PARASOL and CERES/Aqua (SSF1deg)

All Sky

Comparison between CERES/AQUA and POLDER/PARASOL shortwave fluxes: analysis of POLDER/PARASOL diurnal extrapolation
1. Comparison in the ±20° latitudinal belt

2. Regional differences

3. Effects of PARASOL drift on instantaneous albedo

4. POLDER RB3: diurnal extrapolation

5. First results with new models

6. Perspectives
Comparison in the ±20° latitudinal belt

Regional differences

Effects of PARASOL drift on instantaneous albedo

POLDER RB3: diurnal extrapolation

First results with new models

Perspectives

POLDER RB3, CERES SSF1deg Aqua and CERES SYN1deg Aqua+Terra

Spatial averaging of 20°N-20 °S lat. belt

Good agreement (<2%) when the measurements are coincident
Comparison in the ±20° latitudinal belt

Regional differences

Effects of PARASOL drift on instantaneous albedo

POLDER RB3: diurnal extrapolation

First results with new models

Perspectives

CERES and POLDER shortwave fluxes

Spatial averaging of 20°N-20°S lat. belt

- Good agreement (<2%) when the measurements are coincident
- Values drift when PARASOL’s orbit is lowered
Differences over land/ocean

Relative difference POLDER RB3, CERES SSF1deg and CERES SYN1deg:

- Compensation effect: behaviour different over land / over ocean
- Differences higher with SYN1deg than with SSF1deg
Comparison in the ±20° latitudinal belt

Differences over land/ocean

Relative difference POLDER RB3, CERES SSF1deg and CERES SYN1deg:

- Compensation effect: behaviour different over land / over ocean
- Differences for clear-sky fluxes higher than for all-sky fluxes.
Comparison in the ±20° latitudinal belt

Regional differences

Effects of PARASOL drift on instantaneous albedo

POLDER RB3: diurnal extrapolation

First results with new models

Perspectives
Regional differences

- Same behaviour: increase over oceans, decrease over lands;
- Differences exist for cloudy regions.

Fig. 2: Differences for an average of December, March, June, September.
Regional differences

- Same behaviour: increase over oceans, decrease over lands;
- Differences exist for cloudy regions.

Fig. 3: Differences for an average of December, March, June, September.
Regional differences: clear sky

- Small differences over oceans in 2005/2006;
- Very high differences over bright deserts!

**Fig. 4**: Differences for an average of December, March, June, September, clear sky fluxes.
1. Comparison in the ±20° latitudinal belt
2. Regional differences
3. Effects of PARASOL drift on instantaneous albedo
4. POLDER RB3: diurnal extrapolation
5. First results with new models
6. Perspectives
Cloud fraction and cloud optical thickness

- **Albedo increases with SZA**
  - Graph showing monthly means of Solar Zenith Angle 20°N-20°S.
  - Albedo increases with SZA.

- **Cloud fraction and cloud optical thickness increase**
  - Graphs showing cloud optical thickness and cloud fraction over PARASOL local time.
  - Cloud optical thickness and cloud fraction increase with SZA.
Cloud fraction and cloud optical thickness

Observations between 3:25 p.m. and 4:01 p.m. minus observations between 01:28 p.m. and 01:33 p.m.

2005/2006 min 2012/2013

- Shortwave albedo difference
- Cloud optical thickness difference
- Cloud fraction difference

- Albedo increases where COT or CF increase;
- Observations at 4PM: thicker clouds (especially over lands), more clouds.
Diurnal extrapolation reduces the increase of instantaneous albedo;

Values seem over-attenuated over land but not enough over oceans;

Happens for all sky and clear sky fluxes

→ Need to investigate the ERBE-like part of POLDER’s diurnal extrapolation!
1. Comparison in the ±20° latitudinal belt
2. Regional differences
3. Effects of PARASOL drift on instantaneous albedo
4. POLDER RB3: diurnal extrapolation
5. First results with new models
6. Perspectives
Diurnal extrapolation

Comparison in the ±20° latitudinal belt

Regional differences

Effects of PARASOL drift on instantaneous albedo

POLDER RB3: diurnal extrapolation

First results with new models

Perspectives

Diurnal extrapolation

Comparison between CERES/AQUA and POLDER/PARASOL shortwave fluxes: analysis of POLDER/PARASOL diurnal extrapolation
Importance of having precise models

- Importance of having precise albedo models
  
  ![Graphs showing changes in albedo with solar zenith angle (SZA) for different months.](image)

  - Monthly means don't drift
  - Monthly means decrease after 2009
  - Monthly means increase after 2009
Importance of having precise models

- Importance of having precise albedo models

Comparison in the ±20° latitudinal belt
Regional differences
Effects of PARASOL drift on instantaneous albedo

POLDER RB3: diurnal extrapolation
First results with new models

Perspectives

Importance of having precise models

Comparison between CERES/AQUA and POLDER/PARASOL shortwave fluxes: analysis of POLDER/PARASOL diurnal extrapolation
Refinement of the albedo models

Using PARASOL drift to refine the models

- Current models: 4 months of POLDER-1 observations
- POLDER-1 overpass time: 10:30AM → narrow range of SZA
- Drift of PARASOL after 2009 offers a wider range of SZA...why not use it?

Objectives

- Obtain models that describe the behaviour of the albedo throughout the day
- Attenuate the increase or decrease of monthly means after 2009
- Get rid of the dependence on the hour of measurement
Interest of using POLDER-3 data

POLDER-1: narrow range of $\cos(SZA) = \mu_0$

POLDER-3: extends the range of $\mu_0$
New models: examples

- Wider range of $\mu_0$
- Models applied to POLDER-3 data
1. Comparison in the ±20° latitudinal belt
2. Regional differences
3. Effects of PARASOL drift on instantaneous albedo
4. POLDER RB3: diurnal extrapolation
5. First results with new models
6. Perspectives
New models: relative difference with SSF1deg

- Monthly means drift less for the all sky case
- Quite stable but drift (decrease) after 2012 for the clear sky case
- In both cases, monthly means increase
Comparison in the ±20° latitudinal belt  
Regional differences  
Effects of PARASOL drift on instantaneous albedo  
POLDER RB3: diurnal extrapolation  
First results with new models  
Perspectives  

New models: relative difference with SSF1deg

- All sky fluxes: monthly means increase instead of decreasing, model too "flat"?
- Clear sky fluxes: also increase, but the drift is less dramatic than before.
New models: relative difference with SSF1deg

- **All sky**: there is no compensation effect decrease/increase so the monthly means increase;
- **Clear sky**: slow increase then small decrease after 2012 (from the ocean decrease).
First conclusions

- The new models attenuate the increase/decrease of monthly means of SW fluxes
- Using POLDER/PARASOL data allows a refinement of the models that were in use
- Some scenes still present a drift of values after 2009

Perspectives

- Identify problem for clear and cloudy land fluxes (NDVI?)
- Increase number of cloudy scenes
1. Comparison in the ±20° latitudinal belt

2. Regional differences

3. Effects of PARASOL drift on instantaneous albedo

4. POLDER RB3: diurnal extrapolation

5. First results with new models

6. Perspectives
Multimodal distributions

Ocean very cloudy: 0.5<CF<0.95

How to describe such a distribution with only one model?
New models

Comparison in the ±20° latitudinal belt

Regional differences

Effects of PARASOL drift on instantaneous albedo

POLDER RB3: diurnal extrapolation

First results with new models

Perspectives

New models

Non-liq

Liq, very thick

Liq, thick

Liq, thin

Liq, very thin

Comparison between CERES/AQUA and POLDER/PARASOL shortwave fluxes: analysis of POLDER/PARASOL diurnal extrapolation
Comparison in the ±20° latitudinal belt  
Regional differences  
Effects of PARASOL drift on instantaneous albedo  
POLDER RB3: diurnal extrapolation  
First results with new models  
Perspectives

Global repartition

Fig. 5: Number of occurrences for each scene, January to October 2013.

- Most represented on map = P1 models closer to distribution
Problem of identification?

- Multimodal distribution for cloudy ocean (0.05<CF<0.5)
- Intervals too large in COT or CF?
- Problem of scene identification, superpixel too large?
Comparison in the ±20° latitudinal belt

Regional differences

Effects of PARASOL drift on instantaneous albedo

POLDER RB3: diurnal extrapolation

First results with new models

Perspectives

Thank you!

▶ CERES data were obtained from the NASA Langley Research Center CERES ordering tool at https://ceres.larc.nasa.gov/data/.

▶ POLDER Data provided by the CNES. We thank the AERIS/ICARE Data and Services Center for providing access to the data used in this study.
Monthly mean RMS flux differences
SYN Terra minus SYN Aqua